SOUTHERN BASINS PRESCRIBED WELLS AREA GROUNDWATER MONITORING STATUS REPORT 2002

DWLBC Report

2002/13

The Department of Water, Land and Biodiversity Conservation

Government of South Australia

Southern Basins Prescribed Wells Area groundwater monitoring status report 2002

Scott L. Evans

Groundwater Assessment
Department of Water, Land and Biodiversity Conservation

October 2002

Report DWLBC 2002/13

Government
of South Australia

Groundwater Assessment Division
Department of Water, Land and Biodiversity Conservation
25 Grenfell Street, Adelaide
GPO Box 2834, Adelaide SA 5001

Telephone	National	(08) 8463 6946
	International	+61 8 8463 6946
Fax	National	(08) 8463 6999
	International	+61 8 8463 6999
Website	www.dwlbc.sa.gov.au	

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Evans, S.L., 2002. Southern Basins Prescribed Wells Areas groundwater monitoring status report 2002. *South Australia. Department of Water, Land and Biodiversity Conservation. Report,* DWLBC 2002/13.

Foreword

South Australia's natural resources are fundamental to the economic and social wellbeing of the State. One of the State's most precious natural resources, water is a basic requirement of all living organisms and is one of the essential elements ensuring biological diversity of life at all levels. In pristine or undeveloped situations, the condition of water resources reflects the equilibrium between rainfall, vegetation and other physical parameters. Development of these resources changes the natural balance and may cause degradation. If degradation is small, and the resource retains its utility, the community may assess these changes as being acceptable. However, significant stress will impact on the ability of a resource to continue to meet the needs of users and the environment. Understanding the cause and effect relationship between the various stresses imposed on the natural resources is paramount to developing effective management strategies. Reports of investigations into the availability and quality of water supplies throughout the State aim to build upon the existing knowledge base enabling the community to make informed decisions concerning the future management of the natural resources thus ensuring conservation of biological diversity.

Bryan Harris
Director, Resource Assessment Division
Department of Water, Land and Biodiversity Conservation

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INTRODUCTION

The Southern Basins Prescribed Wells Area (PWA) is located south and west of Port Lincoln on Eyre Peninsula. It covers an area of ~70 km^2 and comprises all or parts of the Hundreds of Lincoln, Wanilla, Lake Wangary, Uley, Sleaford and Flinders. The boundaries of the area are presented on Figure 1.

In general water resources are limited in occurrence throughout the Eyre Peninsula. In the Southern Basins there is very little available surface water with one permanent and two ephemeral saline lakes, and two brackish lakes that feed ephemeral watercourses. However, there are moderately good supplies of groundwater resources, which provide a large part of the reticulated water supply for the Eyre Peninsula.

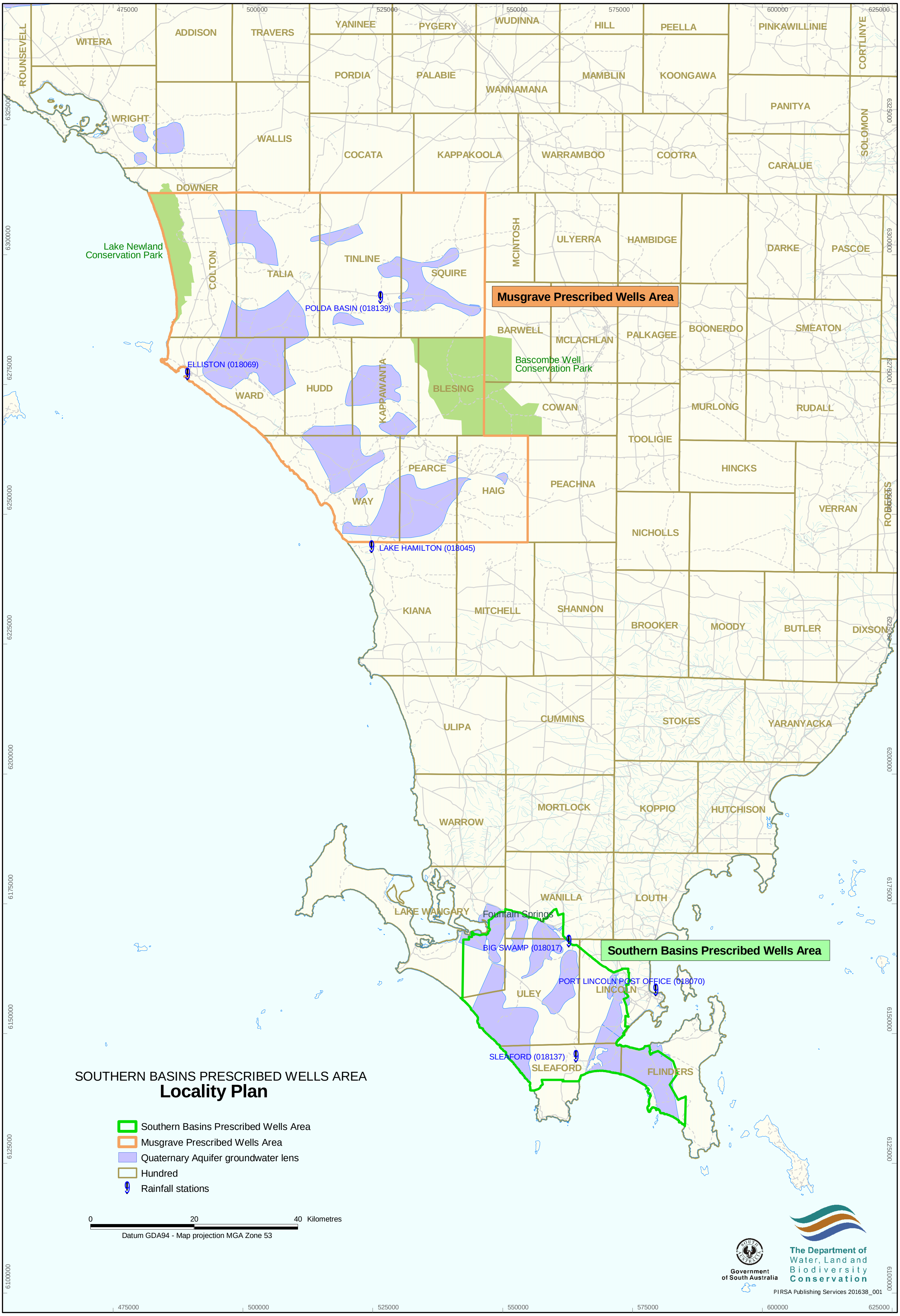
The area is generally characterised by undulating topographic relief typical of an ancient dunal system with dramatic coastal cliffs and large internal drainage catchments. Ground level elevations range from 140 m coastal cliffs to inland depressions reaching near sea level to bedrock highs exceeding 200 m.

The area incorporates the Kellidie Bay and Sleaford Mere Conservation Parks and parts of the Lincoln and Coffin Bay National Parks, which are managed under the *National Parks and Wildlife Act 1972*. Pursuant to this Act, park management plans have been prepared for the Lincoln and Coffin Bay National Parks and Kellidie Bay Conservation Park.

The groundwater resources of the Southern Basins PWA are contained primarily within the Quaternary Bridgewater Formation limestone (Quaternary Limestone) and the Tertiary Sand Aquifers of the Lincoln, Uley and Coffin Bay Basins. Minor groundwater resources are found within the fractured basement rocks. The major resources are within the Quaternary Limestone Aquifer, in separate geologically controlled structures and include the Coffin Bay A–C; Wanilla; Uley Wanilla, Uley East and Uley South; and Lincoln A–D and D West Lenses. A schematic cross-section identifying the key hydrogeological units of the Southern Basins PWA is provided in Figure 2.

The thin soils over the limestone promote rapid infiltration of rainfall that favours relatively high recharge rates in selective areas. Increased understanding of the natural processes operating within these groundwater resources suggests that the primary source of recharge water to these aquifers is from infiltration of rainfall directly onto the land overlying them. The shallow occurrence of these groundwater resources increases the vulnerability of the resource to contamination, such that the water quality of these resources is easily threatened. This could be by inappropriate land use such as intensive stock production or by conscious or accidental waste disposal or chemical spill.

South Australian Water Corporation (SA Water) is the major groundwater user within the Southern Basins PWA, withdrawing between 4350 and 8130 ML of groundwater per annum over the last decade (Fig. 3). Fluctuations in groundwater use can generally be attributed to annual rainfall variations and also to the development of the Eyre Peninsula. Extractions by SA Water from the Southern Basins PWA increased notably in the mid 1970s, with the commissioning of the Uley South borefield, which provides the majority of reticulated public water supply. Water from the Tod River Reservoir is now always mixed with groundwater to dilute its salinity.



SOUTHERN BASINS PRESCRIBED WELLS AREA
Locality Plan
Southern Basins Prescribed Wells Area
Musgrave Prescribed Wells Area
Quaternary Aquifer groundwater lens
Hundred
Rainfall stations
0
20
40
Kilometres
Datum GDA94 - Map projection MGA Zone 53
Lake Newland Conservation Park
Bascombe Well Conservation Park
POLDA BASIN (018139)
ELLISTON (018069)
LAKE HAMILTON (018045)
BIG SWAMP (018017)
PORT LINCOLN POST OFFICE (018070)
SLEAFORD (018137)
Fountain Springs
ROUNSEVELL
WITERA
ADDISON
TRAVERS
YANINEE
PYGERY
WUDINNA
HILL
PEELLA
PINKAWILLINIE
CORTLINYE
PORDIA
PALABIE
WANNAMANA
MAMBLIN
KOONGAWA
PANITYA
SOLOMON
WRIGHT
WALLIS
COCATA
KAPPAKOOLA
WARRAMBOO
COOTRA
CARALUE
DOWNER
COLTON
TALIA
TINLINE
SQUIRE
MCINTOSH
ULYERRA
HAMBIDGE
DARKE
PASCOE
BARWELL
MCLACHLAN
PALKAGEE
BOONERDO
SMEATON
WARD
HUDD
KAPPAWANTA
BLESING
COWAN
MURLONG
RUDALL
TOOLIGIE
HINCKS
PEARCE
WAY
HAIG
PEACHNA
VERRAN
ROBERTS
NICHOLLS
KIANA
MITCHELL
SHANNON
BROOKER
MOODY
BUTLER
DIXSON
ULIPA
CUMMINS
STOKES
YARANYACKA
WARROW
MORTLOCK
KOPPIO
HUTCHISON
LAKE WANGARY
WANILLA
LOUTH
ULEY
LINCOLN
SLEAFORD
FLINDERS
Government of South Australia
The Department of Water, Land and Biodiversity Conservation
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Figure 1

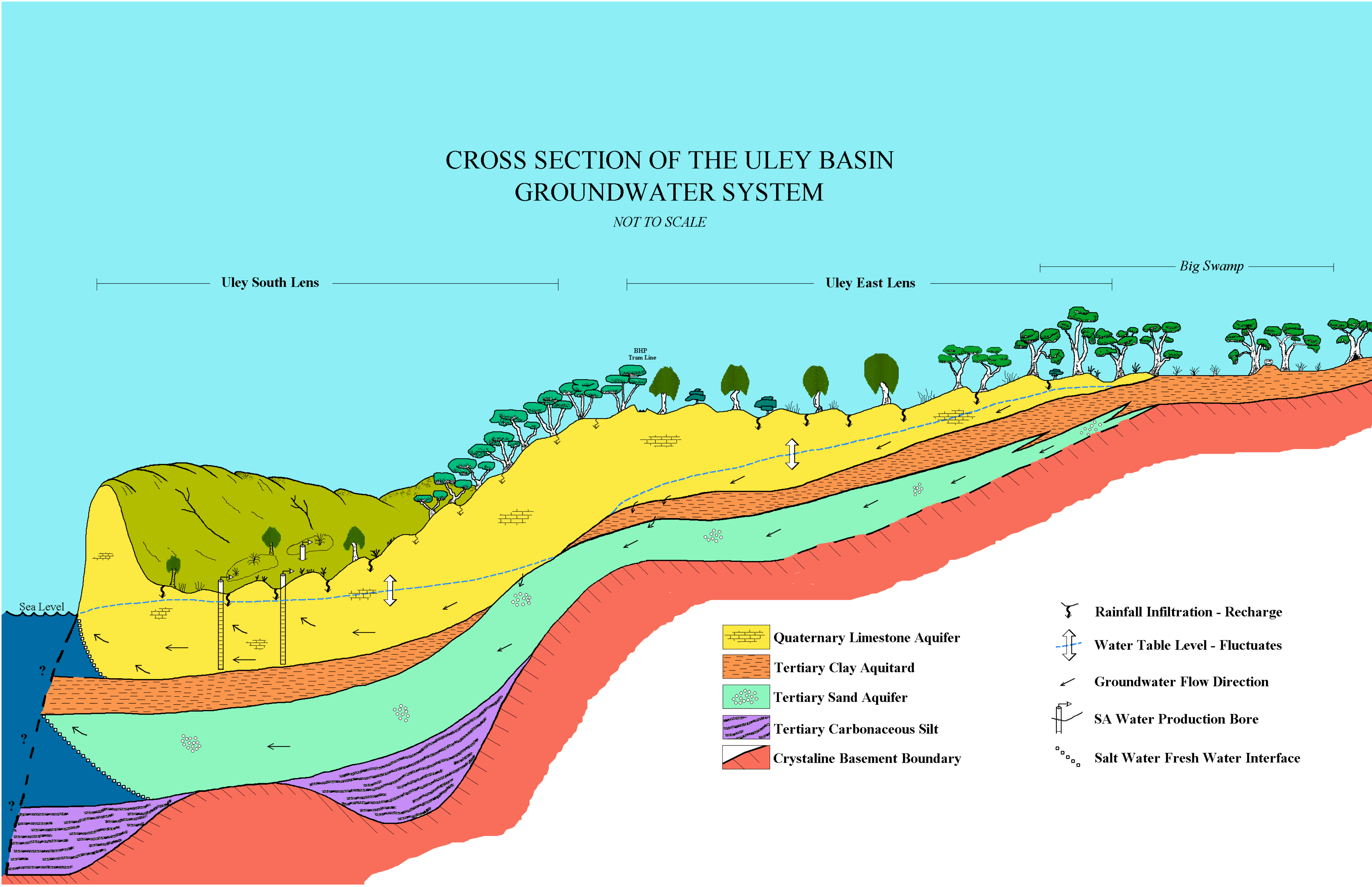

CROSS SECTION OF THE ULEY BASIN
GROUNDWATER SYSTEM
NOT TO SCALE
Uley South Lens
Uley East Lens
Big Swamp
BHP
Tram Line
Sea Level
?
?
?
Quaternary Limestone Aquifer
Tertiary Clay Aquitard
Tertiary Sand Aquifer
Tertiary Carbonaceous Silt
Crystaline Basement Boundary
Rainfall Infiltration - Recharge
Water Table Level - Fluctuates
Groundwater Flow Direction
SA Water Production Bore
Salt Water Fresh Water Interface

Figure 2

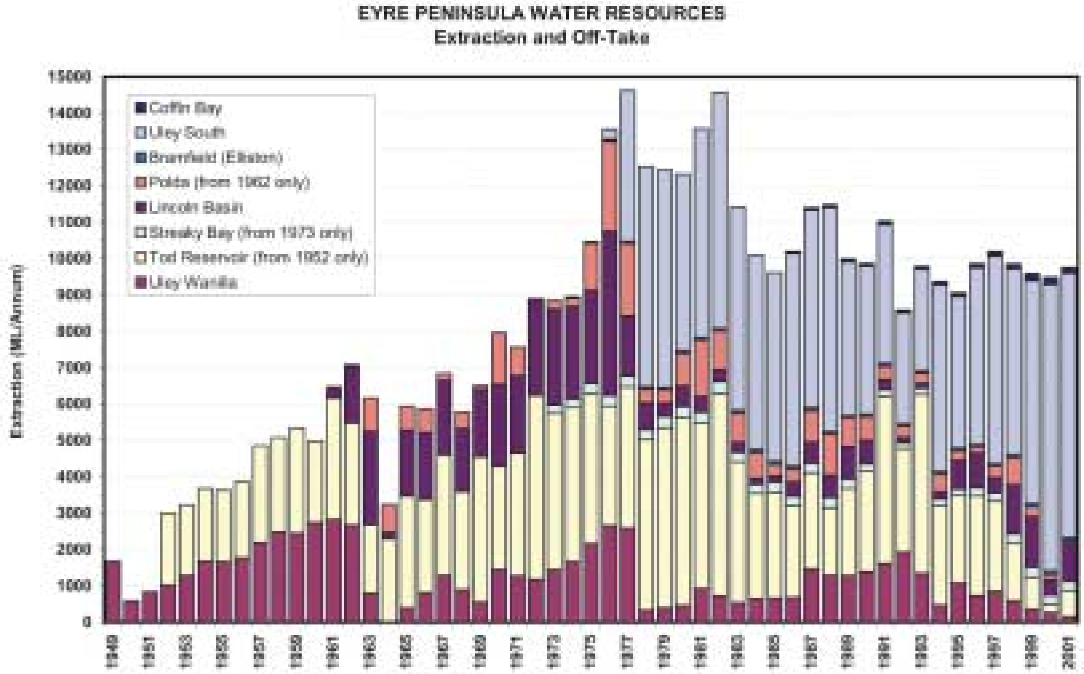


Figure 3

There are 15 water licences within the Southern Basins PWA, and apart from SA Water, approximately only half use groundwater on a regular basis. A survey of these licensed groundwater users estimated that irrigation water licence holders withdrew about 128 ML during the 1991–92 irrigation season. Of this, the major irrigation users were; golf courses (~111 ML), vegetables (~11 ML) and lucerne (~6 ML). Irrigation development is predominantly within the vicinity of Lincoln D, Uley East and the Coffin Bay A Lenses.

CLIMATE

Three rainfall stations located in the vicinity of the Southern Basins PWA were selected as representative of the rainfall pattern throughout the area:

- Port Lincoln Post Office Station 18070
- Big Swamp Station 18017
- Sleaford Station 18137.

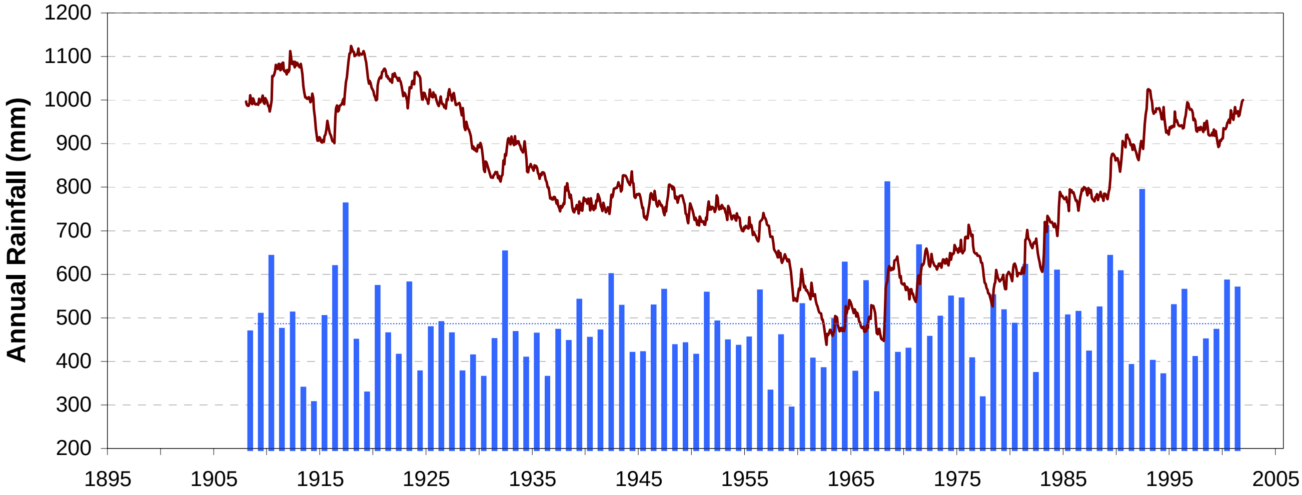
The rainfall records are available for a period of 105 years. Rainfall is winter dominant, with the average monthly and annual rainfall for these stations shown in Table 1.

Table 1. Average monthly rainfall (mm)

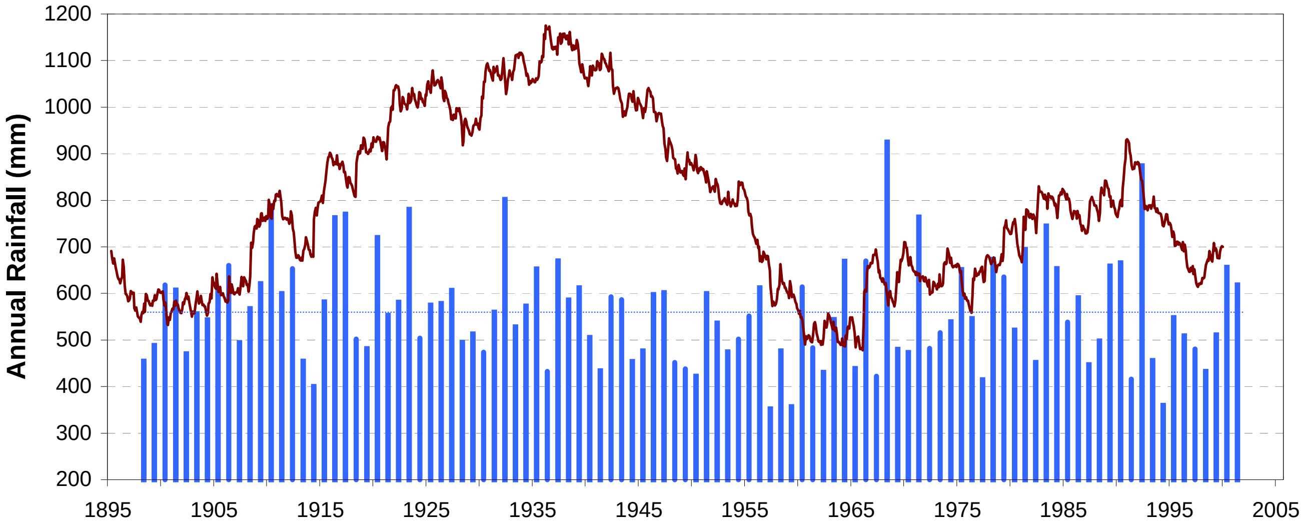
Station	Jan.	Feb.	Mar.	Apr.	May	Jun	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Port Lincoln	11.7	16.8	18.4	35.1	55.3	70.7	80.6	69.1	49.9	35.1	22.3	20.5	485.4
Big Swamp	11.4	17.0	20.8	38.7	65.1	88.7	96.9	78.5	55.7	39.0	25.2	21.1	559.5
Sleaford	10.8	16.2	20.6	40.3	71.4	89.2	103.5	82.6	56.0	39.1	25.0	21.2	575.5

Figure 4 shows the annual rainfall and cumulative deviation from monthly mean obtained from these stations for the period length of continuous recording.

Port Lincoln Post Office - Station No. 18070



BigSwamp - Station No. 18017



Sleaford - Station No. 18137

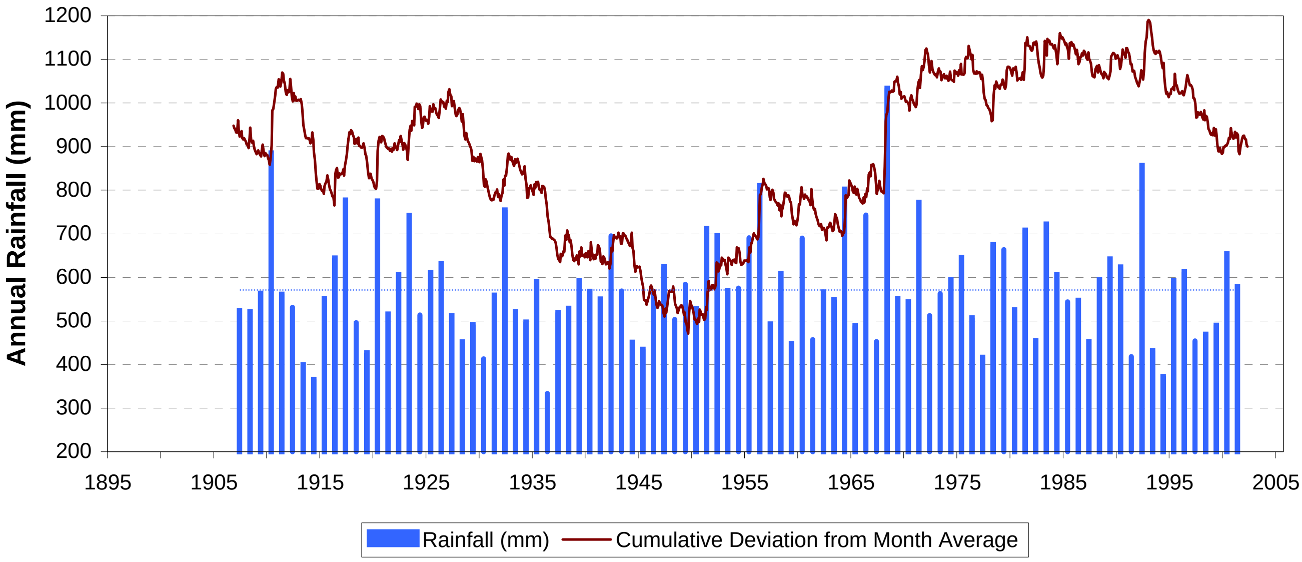


Figure 4 Annual rainfall and cummulative deviation from month averages

HYDROGEOLOGY

Groundwater predominantly occurs in rocks and sediments of three different geological environments within the Southern Basins, namely; Quaternary Bridgewater Formation limestone and Tertiary sand sediments overlaying a volcano–metasedimentary basement sequence. The buried surface of the basement sequence is a series of north–south - trending ridges and valleys. The Quaternary limestone and Tertiary sand sediments tend to be thin over the basement highs, with relatively thick accumulations within the basement troughs.

Figure 5 shows the distribution of observation wells in the Southern Basins PWA.

Quaternary Limestone Aquifer

The unconfined Quaternary Limestone Aquifer occurs as isolated lenses with generally high yields and low salinity (<1000 mg/L TDS). The Quaternary Limestone Aquifer consists of fine shell fragments, which in some areas has developed solution features as well as secondary cementation. The latter is evident as calcretised horizons where evaporation of soil moisture and precipitation of calcium carbonate occurs. This aquifer has been primarily developed for reticulated public water supply.

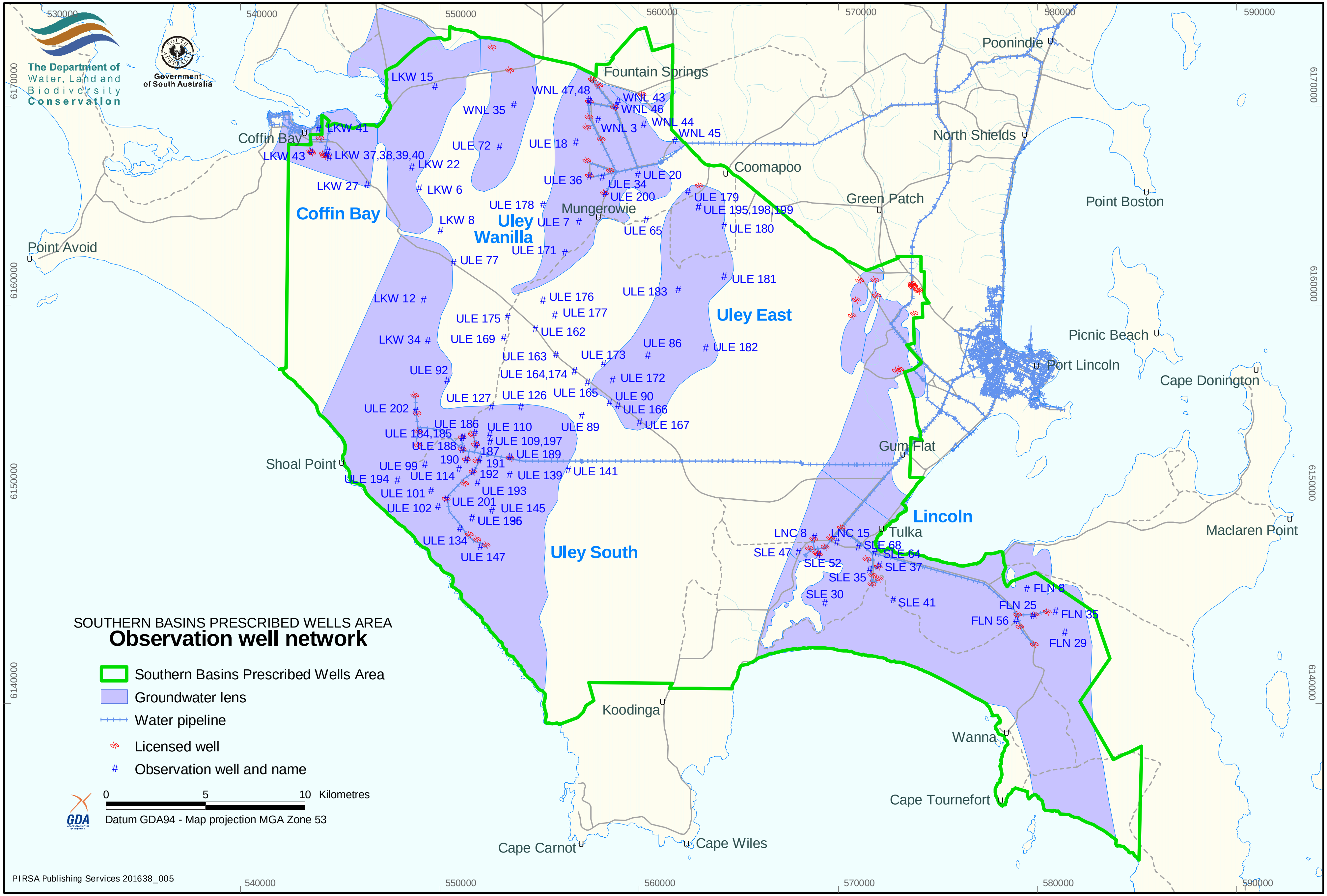
The major lenses of the Quaternary Limestone Aquifer unconfined systems are divided into three distinct zones; Coffin Bay, Uley and Lincoln Basins. Topographic elevation is the major distinction between these basins. Groundwater flow direction of these basins is typically towards the nearest coastline. The lateral extent and watertable contours are shown on Figure 6. The distribution of salinity within this aquifer system is show in Figure 7.

COFFIN BAY BASIN

The Coffin Bay zone comprises three freshwater lenses: Coffin Bay A to C. Principal direction of groundwater flow is northwesterly towards Kellidie Bay. Groundwater discharge is evident as surface springs along the southern coast of Kellidie Bay.

ULEY BASIN

The Uley Basin comprises three major freshwater lenses, Uley Wanilla, Uley East and Uley South, and some minor freshwater lenses. The Uley Wanilla and Uley East Lenses receive recharge primarily from direct rainfall infiltration. Big Swamp also recharges the Uley East Lens when its third section fills (about two years in five), and during years of significant above average rainfall (1956, 1968 and 1984 are the most recent) overflow drains south into the Uley East Lens and then rarely into Uley Wanilla Lens. This Big Swamp recharge component appears to be the cause of higher groundwater salinity in the central zone of Uley East Lens. Groundwater flow is generally away from topographically high areas (i.e. near Big Swamp); in a westerly direction in the Uley Wanilla Lens and a southerly direction in the Uley East Lens. Groundwater discharge from these lenses is understood to occur via downward leakage at the lenses' southern limits into the underlying Tertiary Sands Aquifer. The Uley Wanilla Lens also has a northern outlet through an area known as Fountain Springs, where groundwater previously discharged to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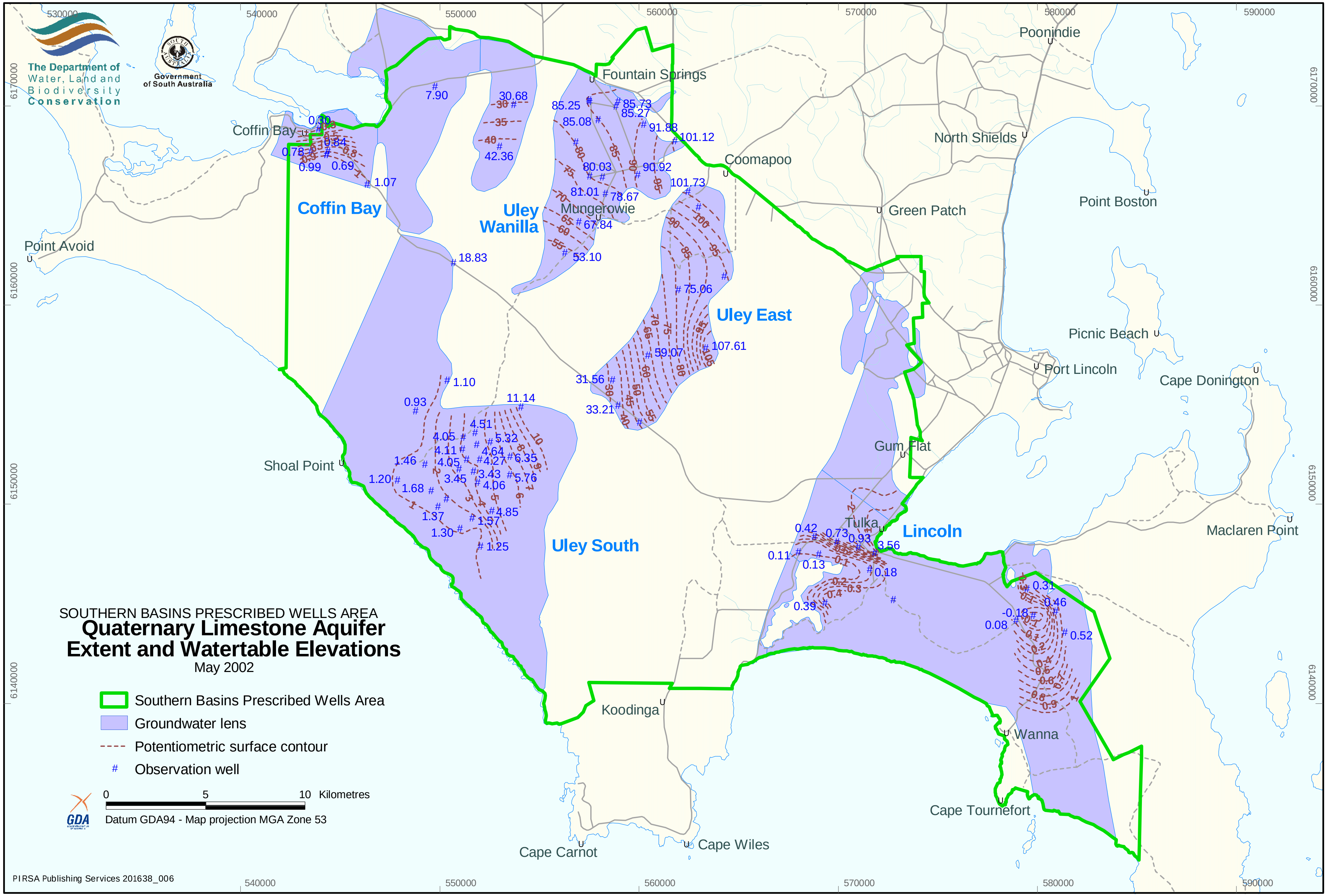
Government of South Australia
SOUTHERN BASINS PRESCRIBED WELLS AREA
Observation well network
Southern Basins Prescribed Wells Area
Groundwater lens
Water pipeline
Licensed well
Observation well and name
0
5
10
Kilometres
Datum GDA94 - Map projection MGA Zone 53
GDA
PIRSA Publishing Services 201638_005
530000
540000
550000
560000
570000
580000
590000
6170000
6160000
6150000
6140000
Coffin Bay
Uley
Wanilla
Uley East
Uley South
Lincoln
Fountain Springs
Poonindie
North Shields
Coomapoo
Green Patch
Point Boston
Mungerowie
Point Avoid
Picnic Beach
Port Lincoln
Cape Donington
Shoal Point
Gum Flat
Tulka
Maclaren Point
Koodinga
Wanna
Cape Tournefort
Cape Carnot
Cape Wiles
LKW 15
LKW 41
LKW 43
LKW 37,38,39,40
LKW 22
LKW 27
LKW 6
LKW 8
LKW 12
LKW 34
WNL 35
WNL 47,48
WNL 43
WNL 46
WNL 44
WNL 3
WNL 45
ULE 72
ULE 18
ULE 36
ULE 20
ULE 34
ULE 200
ULE 178
ULE 7
ULE 65
ULE 179
ULE 195,198,199
ULE 180
ULE 171
ULE 77
ULE 181
ULE 176
ULE 183
ULE 177
ULE 175
ULE 162
ULE 169
ULE 86
ULE 182
ULE 163
ULE 173
ULE 92
ULE 164,174
ULE 172
ULE 127
ULE 126
ULE 165
ULE 90
ULE 202
ULE 166
ULE 186
ULE 110
ULE 89
ULE 167
ULE 184,185
ULE 109,197
ULE 188
187
ULE 189
190
191
ULE 99
ULE 114
192
ULE 139
ULE 141
ULE 194
ULE 101
ULE 193
ULE 201
ULE 102
ULE 145
ULE 196
ULE 134
ULE 147
LNC 8
LNC 15
SLE 47
SLE 68
SLE 64
SLE 52
SLE 37
SLE 35
SLE 30
SLE 41
FLN 8
FLN 25
FLN 56
FLN 35
FLN 29

Figure 5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Government of South Australia
SOUTHERN BASINS PRESCRIBED WELLS AREA
Quaternary Limestone Aquifer Extent and Watertable Elevations
May 2002
Southern Basins Prescribed Wells Area
Groundwater lens
Potentiometric surface contour
Observation well
0 5 10 Kilometres
Datum GDA94 - Map projection MGA Zone 53
PIRSA Publishing Services 201638_006
Coffin Bay
Uley Wanilla
Uley East
Uley South
Lincoln
Poonindie
Fountain Springs
North Shields
Coomapoo
Point Boston
Green Patch
Mungerowie
Point Avoid
Picnic Beach
Port Lincoln
Cape Donington
Gum Flat
Shoal Point
Tulka
Maclaren Point
Koodinga
Wanna
Cape Tournefort
Cape Carnot
Cape Wiles

Figure 6

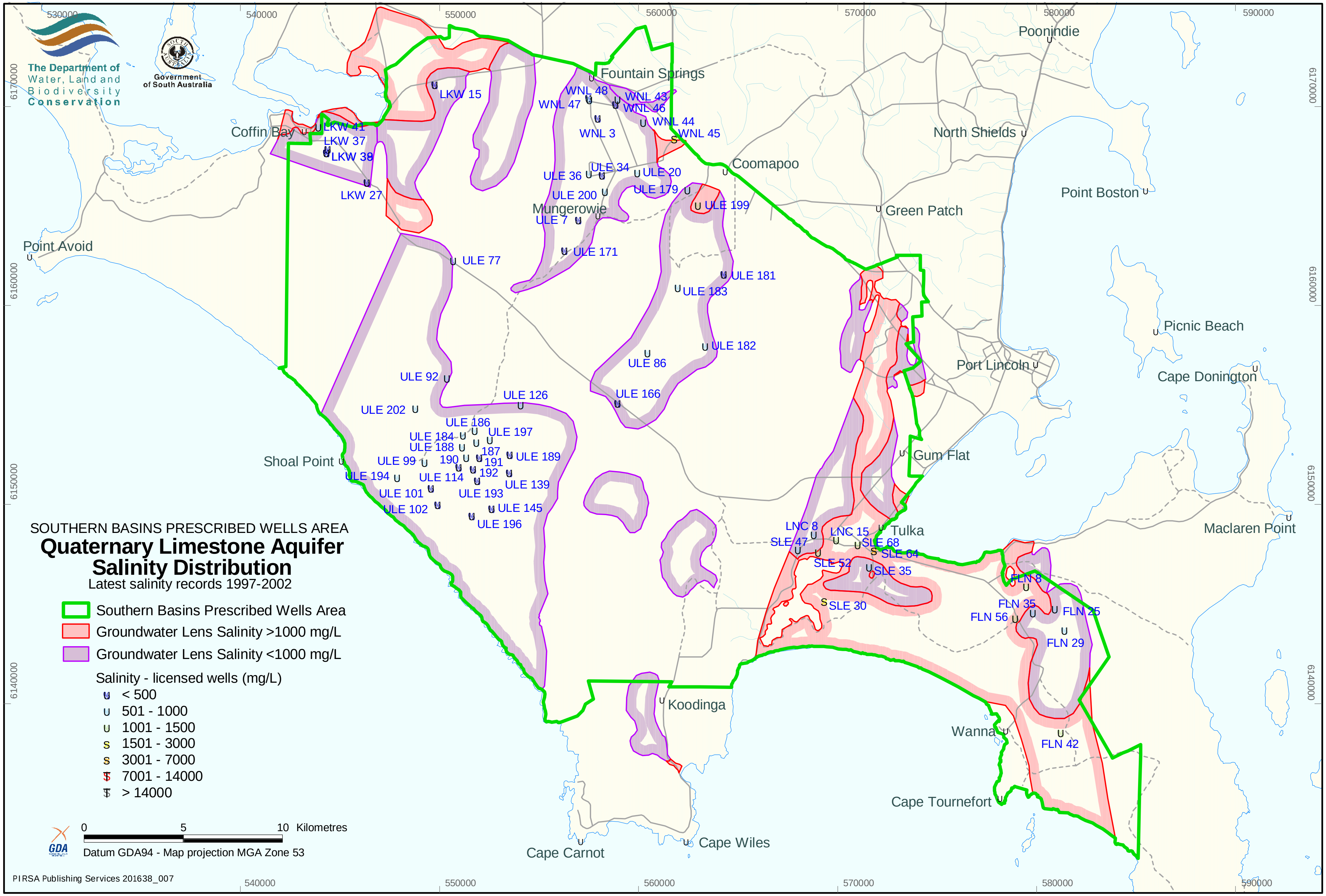

SOUTHERN BASINS PRESCRIBED WELLS AREA
Quaternary Limestone Aquifer
Salinity Distribution
Latest salinity records 1997-2002
Southern Basins Prescribed Wells Area
Groundwater Lens Salinity >1000 mg/L
Groundwater Lens Salinity <1000 mg/L
Salinity - licensed wells (mg/L)
< 500
501 - 1000
1001 - 1500
1501 - 3000
3001 - 7000
7001 - 14000
> 14000
0
5
10
Kilometres
Datum GDA94 - Map projection MGA Zone 53
PIRSA Publishing Services 201638_007
The Department of Water, Land and Biodiversity Conservation
Government of South Australia
530000
540000
550000
560000
570000
580000
590000
6170000
6160000
6150000
6140000
Poonindie
Fountain Springs
Coffin Bay
North Shields
Coomapoo
Point Boston
Green Patch
Mungerowie
Point Avoid
Picnic Beach
Port Lincoln
Cape Donington
Gum Flat
Shoal Point
Tulka
Maclaren Point
Koodinga
Wanna
Cape Tournefort
Cape Carnot
Cape Wiles
LKW 15
LKW 41
LKW 37
LKW 38
LKW 27
WNL 48
WNL 47
WNL 43
WNL 46
WNL 44
WNL 3
WNL 45
ULE 36
ULE 34
ULE 20
ULE 179
ULE 199
ULE 200
ULE 7
ULE 171
ULE 77
ULE 181
ULE 183
ULE 182
ULE 86
ULE 92
ULE 126
ULE 166
ULE 202
ULE 186
ULE 197
ULE 184
ULE 188
ULE 99
190
187
191
ULE 189
ULE 194
ULE 114
192
ULE 139
ULE 101
ULE 193
ULE 102
ULE 145
ULE 196
LNC 8
LNC 15
SLE 47
SLE 68
SLE 64
SLE 52
SLE 35
SLE 30
FLN 8
FLN 35
FLN 56
FLN 25
FLN 29
FLN 42

Figure 7

the surface. This discharge has been controlled through construction of low permeability barrier and sump pumps. Current water levels in the Uley Wanilla Lens are too low for the natural outflow from the Fountain Spring area to occur.

The Uley South Lens receives recharge only via direct infiltration of incident rainfall. Dominant groundwater flow within the Uley South Lens is southwest towards the Southern Ocean and westward toward the sand dunes within the Coffin Bay National Park. No groundwater investigations have been undertaken beneath the sand dunes of Coffin Bay National Park.

LINCOLN BASIN

The Lincoln Basin comprises of freshwater lenses: Lincoln A to D. Recharge to Lincoln A to C Lenses is via direct rainfall infiltration. Principal directions of groundwater flow are northeasterly within Lincoln A and northerly within Lincoln B towards Port Lincoln proper. Discharge from these lenses is evident as surface springs near Tulka West. Groundwater flow within Lincoln C is predominantly northwesterly towards Port Lincoln proper and south westerly towards the Southern Ocean. Recharge to Lincoln D is via direct rainfall infiltration and surface water inflow from Little Swamp — the latter being the cause of the higher groundwater salinity in the northern portion of Lincoln Basin. Groundwater flow within Lincoln D is southerly towards the ocean at Port Lincoln Proper Bay. The smaller Lincoln D West Lens receives only local rainfall recharge and has a northward groundwater flow direction towards Little Swamp.

Table 2 shows the hydrogeology of the Eyre Peninsula.

Table 2. Hydrogeology of Eyre Peninsula

Groundwater predominantly occurs in rocks and sediments of five different geological environments.

Age			Stratigraphy	Hydrostratigraphy	Southern Basins	Musgrave	Streaky Bay
Cainozoic	Recent	Holocene	*Coastal dunes:* Fine-grained aeolianites, unconsolidated, actively mobile. Grains comprise calcite and shell fragments.	*Unconfined aquifer:* seasonal, small yielding, thin, low salinity supplies located at the base of the mobile sand dune systems	**Semaphore Sand and Gantheaume Sand Members (St Kilda Formation) (Qhcks, Qhckg)**		
	Quaternary	Pleistocene	*Bridgewater Formation:* Aeolianites, fine to medium-grained, cross-bedded, weakly to moderately cemented, Grains are calcite and shell fragments, mainly 0.1–1.5 mm. Generally calcrete at surface.	*Unconfined aquifer:* generally low salinity. Permeability ranges from low to very high. Transmissivity ranges from 2.0 x 10^3 to 8.0 x 10^3 m^3/d/m. The usual target aquifer for large water supplies on Eyre Peninsula.	**Bridgewater Formation (Qpcb)**		
	Tertiary	Eocene	*Uley Formation:* Sandstone, clayey to orange–brown quartz, well sorted and rounded, minor lateritic and non-lateritic gravel.	*Aquitard:* generally a confining layer beneath the Quaternary Aquifer. Where it is permeable can hold the watertable or allow infiltration to the underlying sediments	**Uley Formation (TpQau)**	**Undifferentiated (TpQ)**	
			Wanilla, Poelpena and Pidinga Formations: Clays, sands (quartz) and gravels with thin lignite layers. Sand is generally fine-grained, less than 0.5 mm, uncemented or weakly cemented.	*Semi-confined to confined aquifer:* low to moderate permeability but with marked variations vertically and laterally. Salinity variable and generally higher than the overlying unconfined aquifer.	**Wanilla Formation (Tbw)**	**Poelpena Formation (Tbe)**	**Pidinga Formation (Tbp)**
Mesozoic	Jurassic		*Polda Formation:* Sands (quartz), silts and clays. Sand grains usually less than 0.5 mm; occasionally up to 3 mm. Sediments generally carbonaceous and contain lignite beds.	*Confined aquifer:* very low permeability, high groundwater salinity generally exceeding 14 000 mg/L.		**Polda Formation (J-o)**	
Proterozoic	Neo-Proterozoic		*Pre-Cambrian Basement:* Schists, gneisses and quartzites intruded by granites and basic rocks. Deeply weathered in places.	*Semi-confined to confined aquifers:* groundwater occurs in the weathered profile or within the fracture spaces of these rocks. Salinity generally exceeds 7000 mg/L, occasionally lower.	**(Als, Lh)**	**(Als, Mcb, Lh)**	**(Mh, Lp)**

Note: Shaded cells represent the presence of an aquitard.
The Jurassic is not present in two regions.

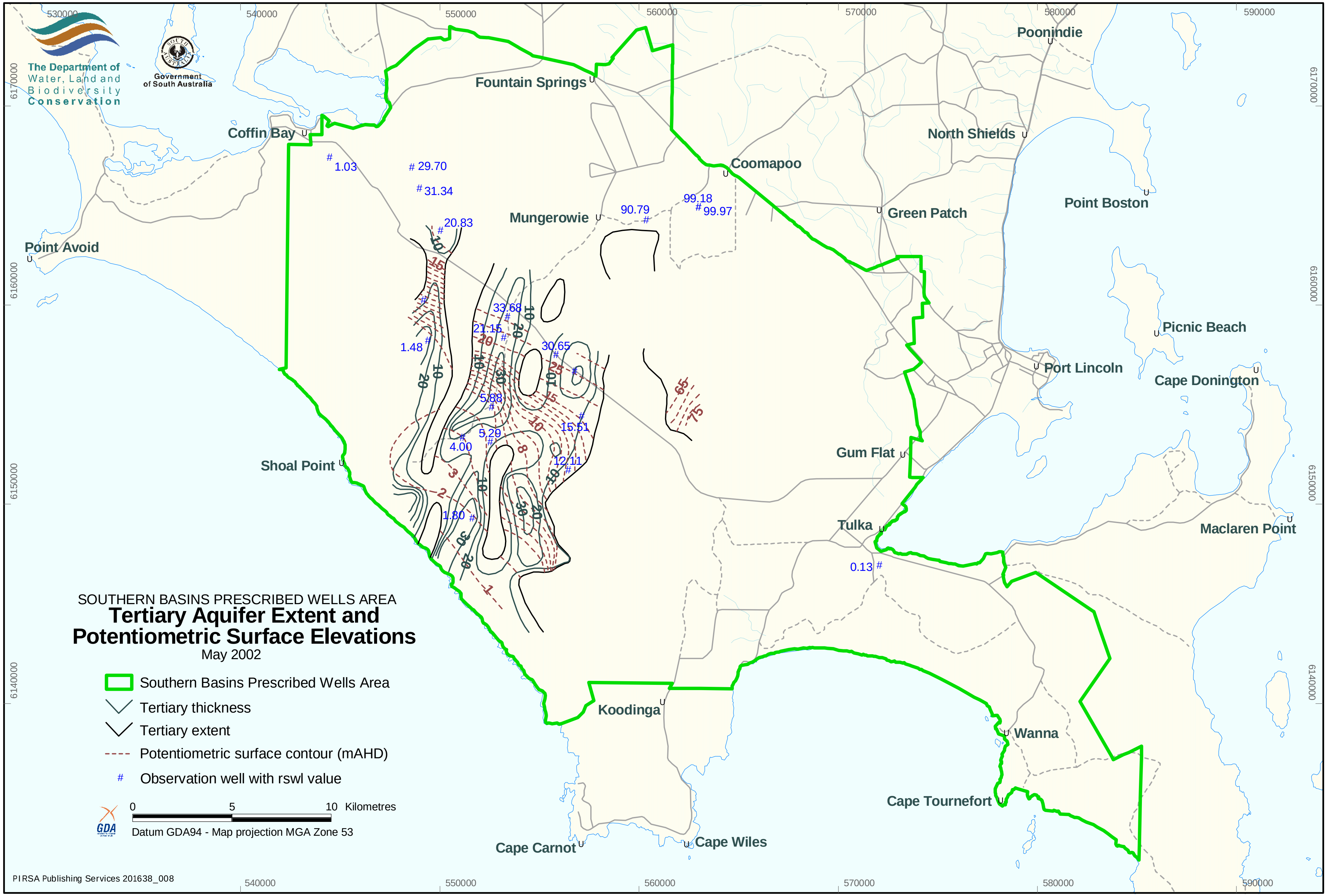
Tertiary Sands Aquifer

The Tertiary Sands Aquifer generally occurs throughout the area and is predominant adjacent the Southern Ocean coastline and underlies the Quaternary Limestone Aquifer. The Tertiary Sands Aquifer consists of unconsolidated fine quartz-sands, has significant storage, a salinity from 500–5500 mg/L TDS, but poor to moderate yields. Due to the unconsolidated nature of this fine quartz-sand aquifer, extraction difficulties exist which have limited development of the Tertiary Sands Aquifer to local stock and domestic supplies. The current understood lateral extent and potentiometric surface contours are shown on Figure 8, and the distribution of salinity within the aquifer system is shown on Figure 9.

The Tertiary Sands Aquifer receives downward leakage as recharge from the Quaternary Limestone Aquifer in the southern portions of the Quaternary Uley Wanilla – Uley East Lenses, and represents the watertable between these lenses and the Quaternary Uley South Lens. In this area recharge via direct rainfall is considered limited due to the dense eucalyptus vegetation present. In the northeast portion of the Quaternary Uley South zone where the Tertiary clay aquitard is absent, the Tertiary system is hydraulically connected with and thereby receives recharge from the Quaternary system. Otherwise, the Tertiary system is generally confined by the Tertiary clay aquitard from the remainder of the Quaternary Uley South Lens. Groundwater flow within the Tertiary system is predominantly in a south, southwesterly direction towards the Southern Ocean. The Tertiary system is thought to be in hydraulic continuity with the sea, as observed oscillations in piezometric water levels coincide with tidal fluctuations.

Basement Aquifer

There is limited information and understanding of the Basement Aquifer. The groundwater resource is found within a fractured rock environment, which is poorly defined and appears to be irregular in occurrence, salinity and yield within the Southern Basins PWA. The small level of development of the Basement Aquifer within the Southern Basins PWA is primarily for stock and domestic purposes.



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SOUTHERN BASINS PRESCRIBED WELLS AREA
Tertiary Aquifer Extent and Potentiometric Surface Elevations
May 2002
Southern Basins Prescribed Wells Area
Tertiary thickness
Tertiary extent
Potentiometric surface contour (mAHD)
Observation well with rswl value
0 5 10 Kilometres
Datum GDA94 - Map projection MGA Zone 53
PIRSA Publishing Services 201638_008
Poonindie
Fountain Springs
Coffin Bay
North Shields
Coomapoo
Point Boston
Green Patch
Mungerowie
Point Avoid
Picnic Beach
Port Lincoln
Cape Donington
Gum Flat
Shoal Point
Tulka
Maclaren Point
Koodinga
Wanna
Cape Tournefort
Cape Carnot
Cape Wiles
1.03
29.70
31.34
20.83
90.79
99.18
99.97
33.68
21.15
1.48
30.65
5.88
5.29
4.00
15.51
12.11
1.80
0.13
530000
540000
550000
560000
570000
580000
590000
6170000
6160000
6150000
6140000

Figure 8

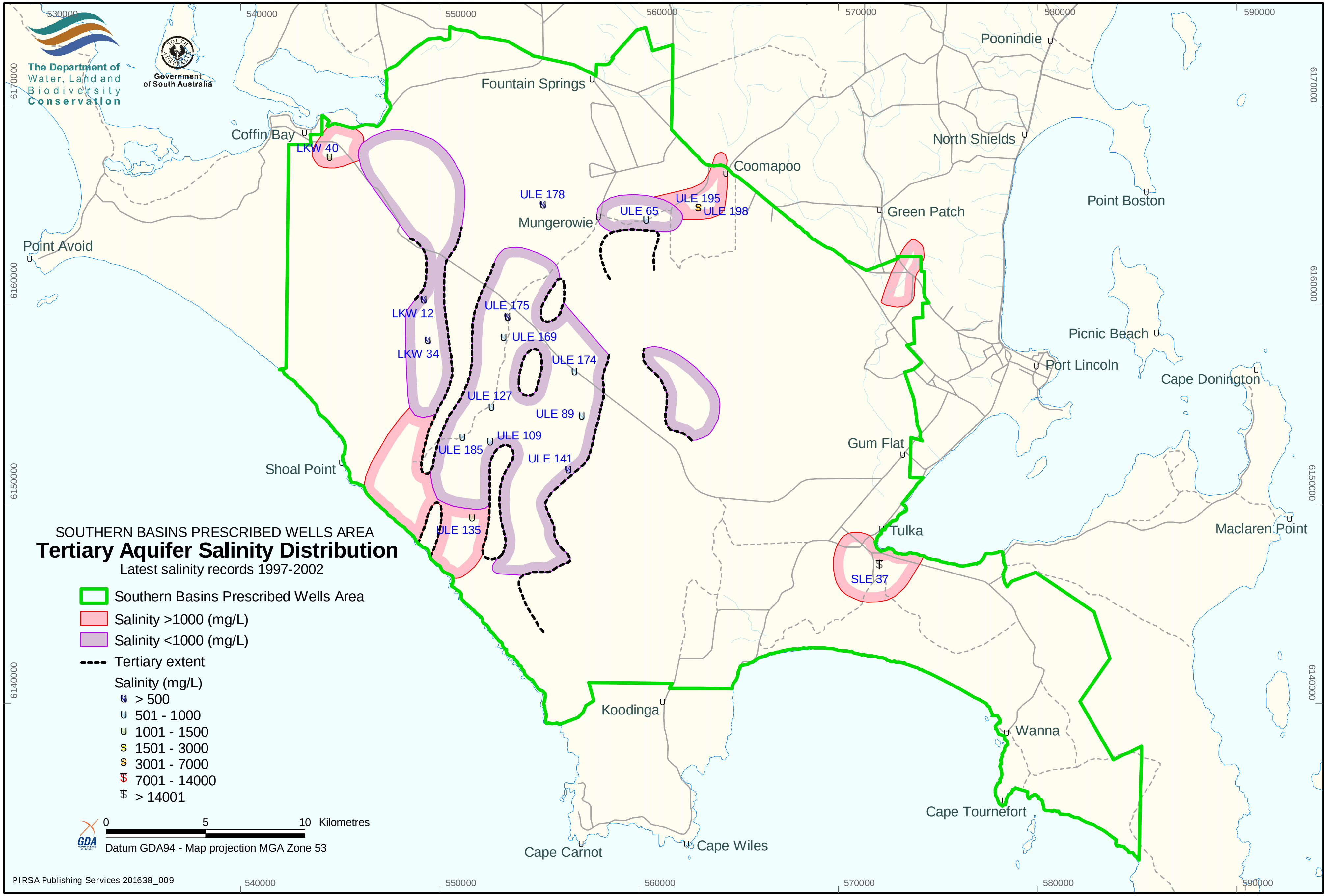

The Department of Water, Land and Biodiversity Conservation
Government of South Australia
SOUTHERN BASINS PRESCRIBED WELLS AREA
Tertiary Aquifer Salinity Distribution
Latest salinity records 1997-2002
Southern Basins Prescribed Wells Area
Salinity >1000 (mg/L)
Salinity <1000 (mg/L)
Tertiary extent
Salinity (mg/L)
> 500
501 - 1000
1001 - 1500
1501 - 3000
3001 - 7000
7001 - 14000
> 14001
0 5 10 Kilometres
Datum GDA94 - Map projection MGA Zone 53
PIRSA Publishing Services 201638_009
Poonindie
Fountain Springs
Coffin Bay
North Shields
Coomapoo
Point Boston
Green Patch
Mungerowie
Point Avoid
LKW 40
ULE 178
ULE 65
ULE 195
ULE 198
LKW 12
LKW 34
ULE 175
ULE 169
ULE 174
ULE 127
ULE 89
ULE 109
ULE 185
ULE 141
ULE 135
Picnic Beach
Port Lincoln
Cape Donington
Gum Flat
Shoal Point
Tulka
SLE 37
Maclaren Point
Koodinga
Wanna
Cape Tournefort
Cape Carnot
Cape Wiles

Figure 9

RECHARGE TO THE GROUNDWATER RESOURCES WITHIN THE PRESCRIBED WELLS AREA

The water resources on the Eyre Peninsula are dependent on local rainfall as the source of water. There is no regional inflow of water, either surface or underground to the Eyre Peninsula.

Quaternary Limestone Aquifer

The major lenses of the Quaternary Limestone Aquifer are primarily dependent upon local rainfall falling directly on the overlying land for recharge. Surface water runoff from catchments adjacent the aquifers only contributes a minor portion of (usually poor quality) water to some of the Quaternary lenses.

Water level behaviour within the Quaternary lenses reveals that recharge occurs after intense rainfall events, where short lived overland flow allows the water to enter the solution features (sink-holes) and reach the watertable rapidly. Research of the Uley Basin system indicates that these resources show an annual water level rise when they receive more than 10 days of greater than 10 mm of rainfall between the months of May and October. Of the annual rainfall, it is estimated that between 10 and 30% will infiltrate as recharge to these Quaternary lenses.

As recharge to these systems is dependent on seasonal rainfall patterns, water levels show a strong relationship to periods of above and below average winter rainfall. Historic rainfall data has indicated that above or below average trends can last up to 25 years. For effective management of these resources, consideration must be given to the recent climatic conditions prior to any utilisation.

Tertiary Sand Aquifer

Recharge to the Tertiary Sand Aquifer is irregular. Where the Tertiary clay under the Quaternary Limestone Aquifer lenses confines the Tertiary Sand Aquifer, the aquifer receives negligible recharge. Where this clay is non-confining, the aquifer receives vertical leakage from the Quaternary aquifers and direct infiltration of rainfall. The unconfined Tertiary Sand Aquifer water level changes in response to seasonal recharge are muted relative to the Quaternary aquifers. This suggests that these systems may receive significantly less annual recharge than the Quaternary aquifers and that the time taken for recharging water to reach the watertable is longer.

Basement Aquifer

Recharge to this system is localised and irregular. Apart from vertical leakage from the overlying aquifers, recharge to this fractured rock environment is limited to surface exposures, usually where basement highs occur throughout the PWA. The rate of recharge is variable and is a function of the geomorphology of the exposure, the degree of fracturing present and the composition of the basement rock type (i.e. of metamorphic or igneous nature).

MONITORING NETWORK

Groundwater monitoring in the Southern Basins PWA began in the late 1930s. Historically 409 observation wells have been constructed. Currently 103 observation wells (Fig. 5) are monitored on a regular monthly basis for water levels. Of these wells:

- 77 monitor the shallow Quaternary Bridgewater Formation Limestone Aquifer (Qpcb; Quaternary Limestone Aquifer)
- four monitor the Tertiary Uley Formation clay (TpQau; Tertiary clay)
- 20 monitor the Tertiary Wanilla Formation Sand Aquifer (Tbw; Tertiary Sand Aquifer)
- two monitor the Basement Aquifer system (ALs).

Water quality monitoring occurs less frequently, as TDS tends to vary at a slower rate. Currently 63 observation wells are monitored randomly (six-monthly from 1992 to 1997 with the area soon to be revisited) for TDS. Of these wells:

- 48 monitor the shallow Quaternary Bridgewater Formation Limestone Aquifer (Qpcb; Quaternary Limestone Aquifer)
- three monitor the Tertiary Uley Formation clay (TpQau; Tertiary clay)
- 11 monitor the Tertiary Wanilla Formation Sand Aquifer (Tbw; Tertiary Sand Aquifer)
- one monitors the Basement Aquifer system (ALs).

The monitoring of the Uley South Lens is currently under review due to the increased reliance the reticulated water supply system has on this resource.

Groundwater level trends

The observation well network primarily focuses on the Quaternary Limestone Aquifer (Fig. 5). The general trends during the years 1969–72, 1984–85 and 1992–93 have been groundwater level rises and steady groundwater salinity trends associated with recharge events. From 1993 to 2000 there was a general decline in groundwater levels, as below average rainfall pattens led to no significant recharge (Figs 10–14). The years 2000–01 have seen a response of rising water levels as rainfall patterns return to average.

Groundwater flow (discharge) and extractions are the primary factors affecting aquifer storage. The Uley Wanilla, Uley South, Coffin Bay A and Lincoln A to C Lenses have been developed for reticulated public water supply. The Uley Wanilla Lens has experienced dramatic water level decline due to previous over-extraction practices. Recent research has refined the understanding of the hydrological processes that operate within these aquifers and has determined the amount of water that is available for extraction with acceptable impacts to the resources.

Groundwater level decline has occurred in all lenses over the last 10 years, irrespective of large-scale withdrawals. Uley East and Coffin Bay C Lenses have generally only been developed for stock and domestic purposes, and the groundwater level trends of these have also notably declined since 1993 (Figs 10–14). This highlights how dominating effective rainfall is for recharge for both developed and undeveloped lenses. Also natural groundwater discharge from the unconfined Quaternary Limestone Aquifers is an ongoing process, irrespective of recharge.

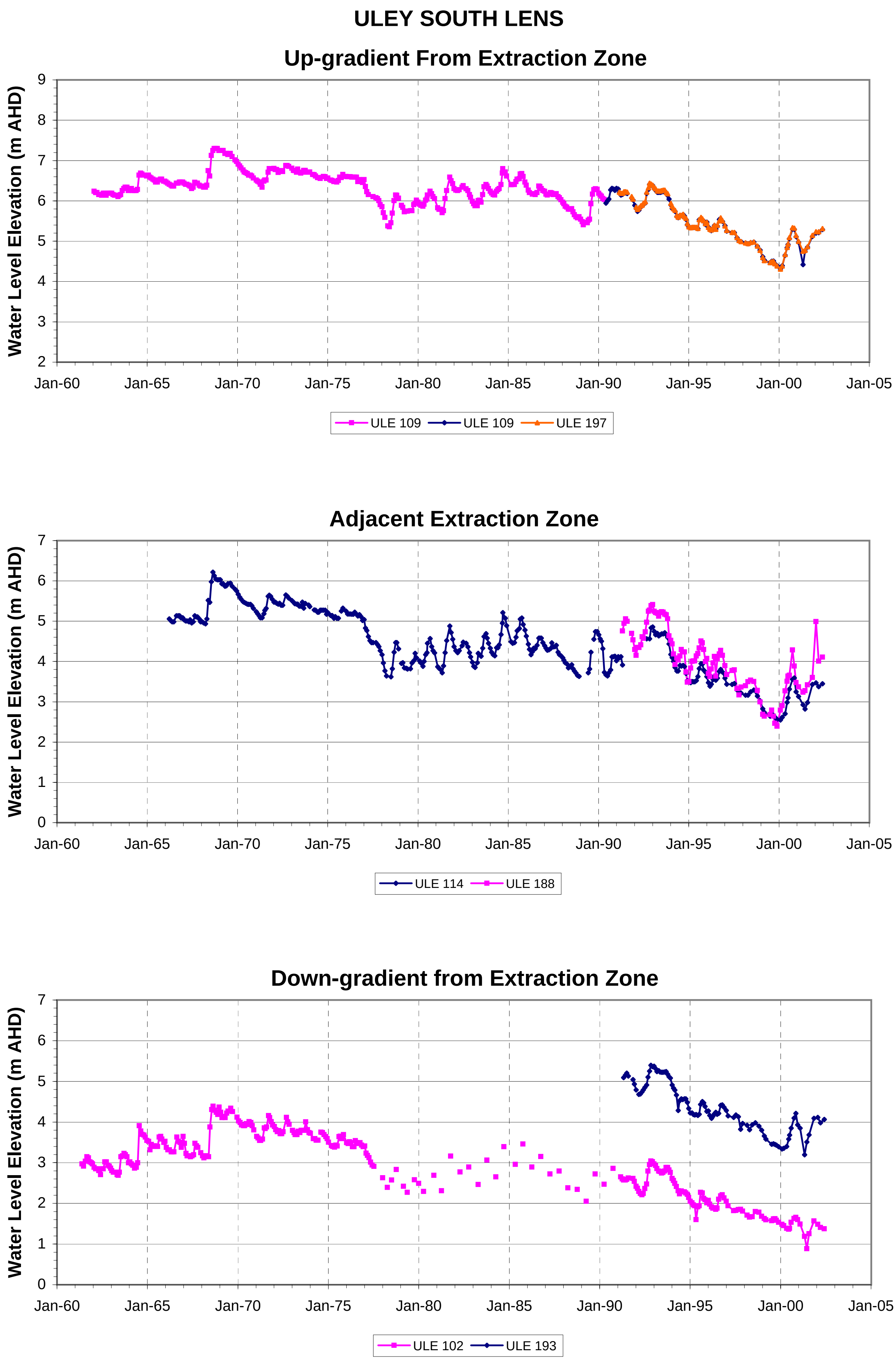
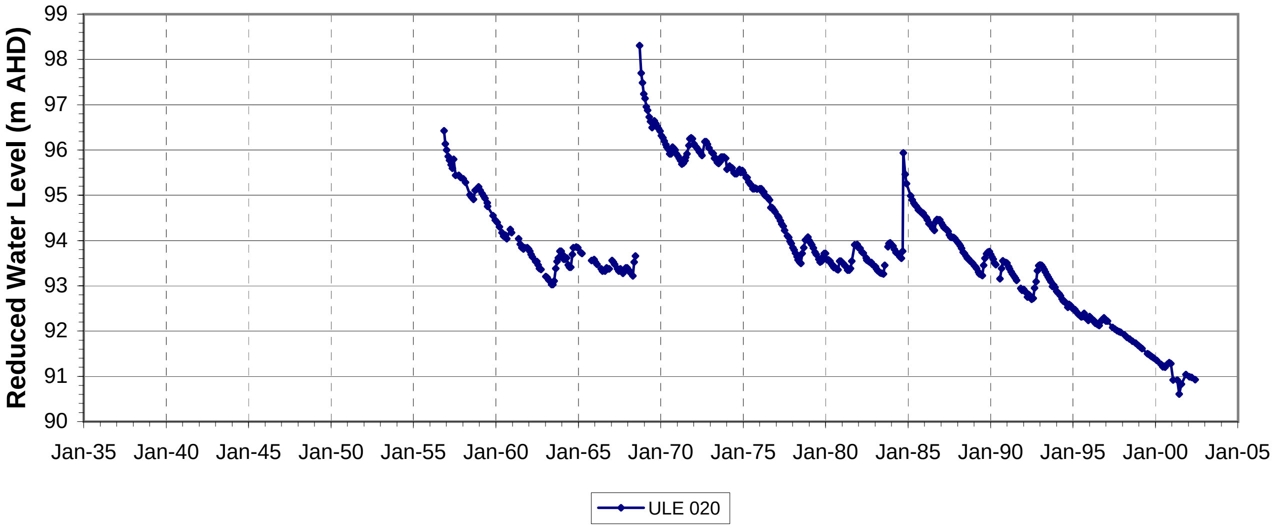
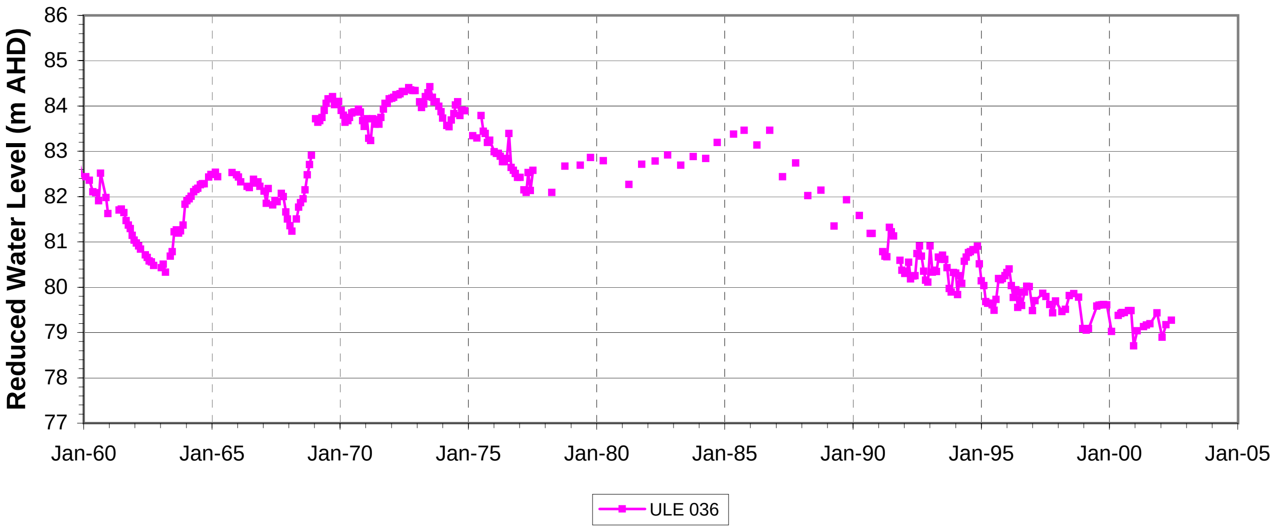


Figure 10 Uley South Lens, Quaternary Limestone Aquifer hydrographs

Up-gradient from Extraction Zone



Adjacent Extraction Zone



Down-gradient from Extraction Zone

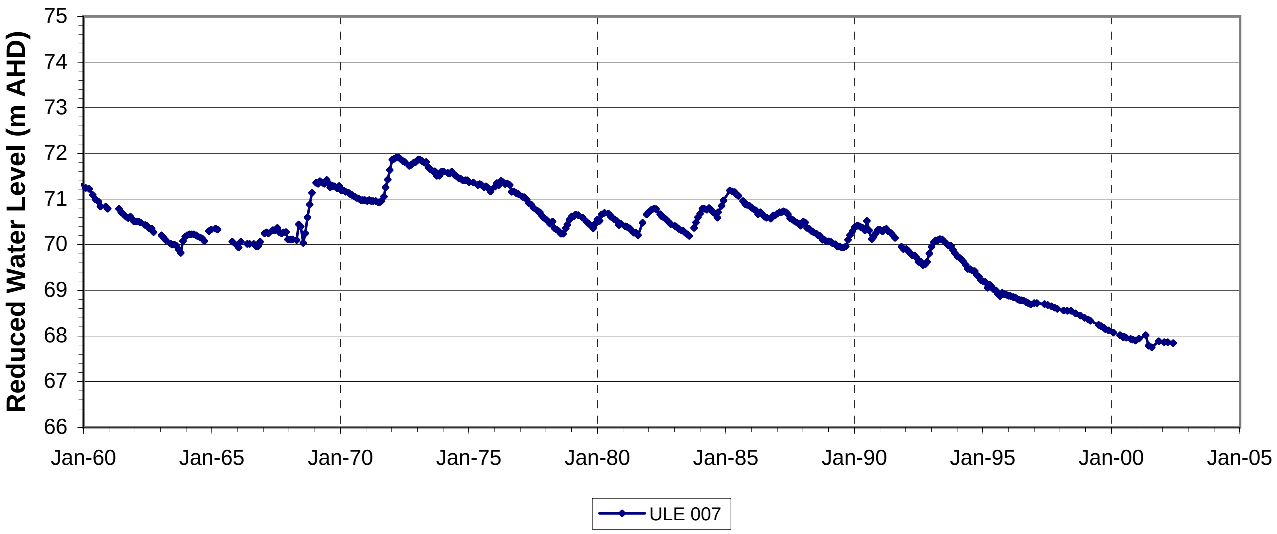
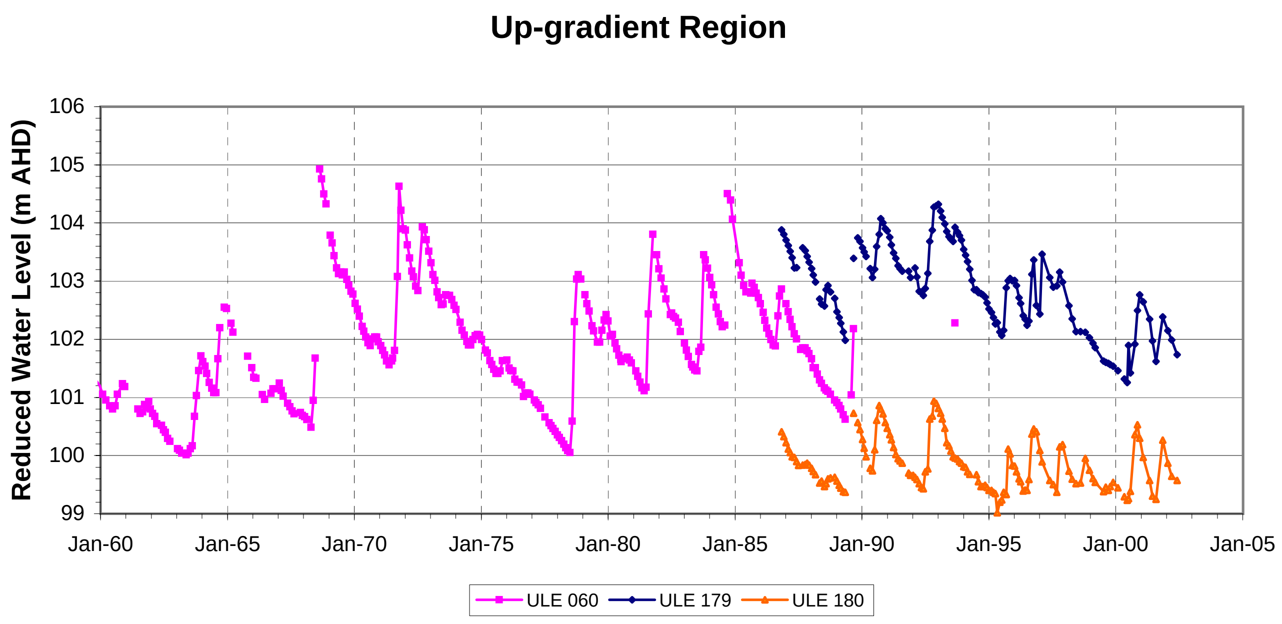
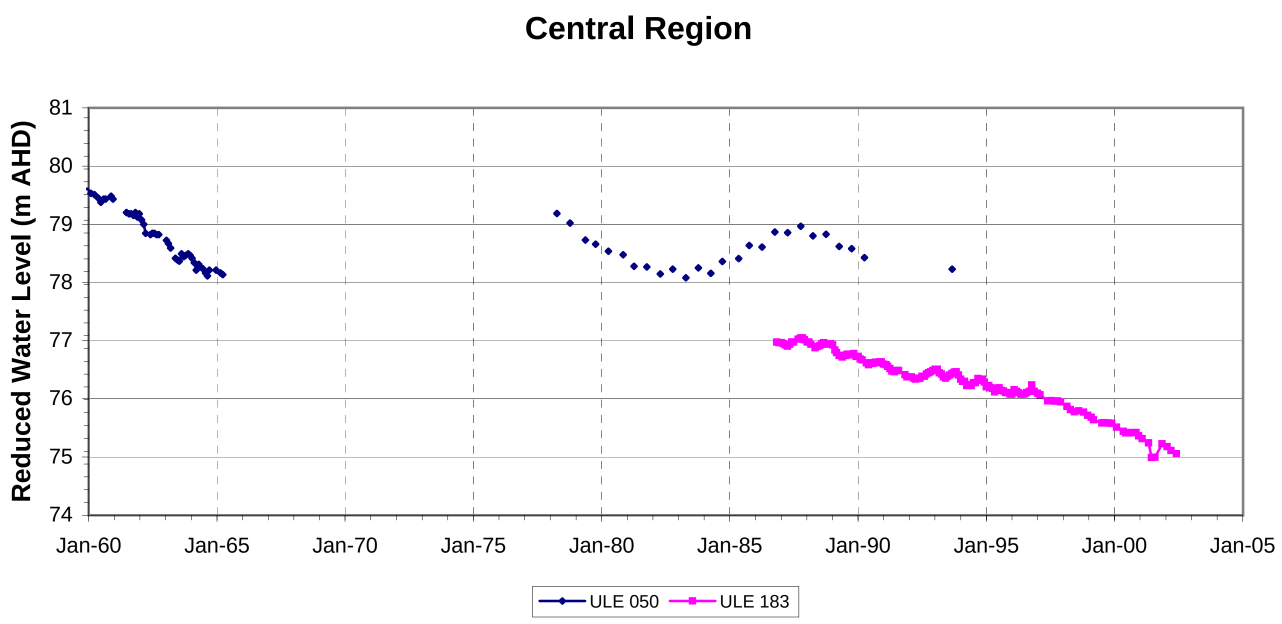


Figure 11 Uley Wanilla Lens, Quaternary Limestone Aquifer hydrographs





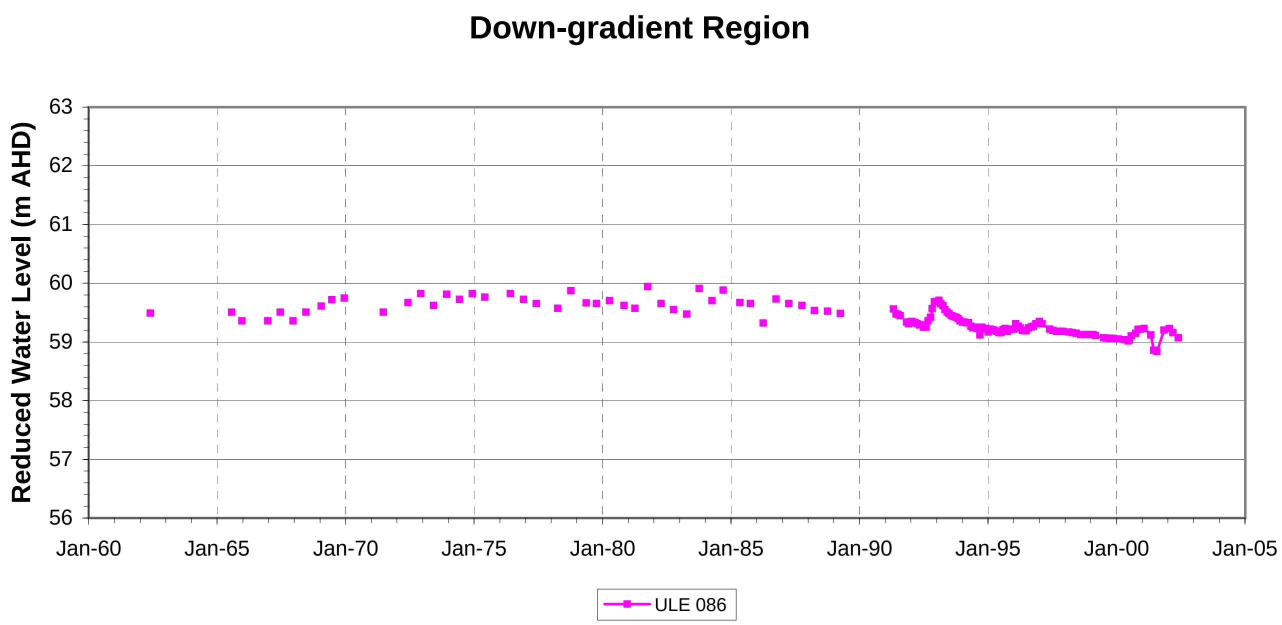
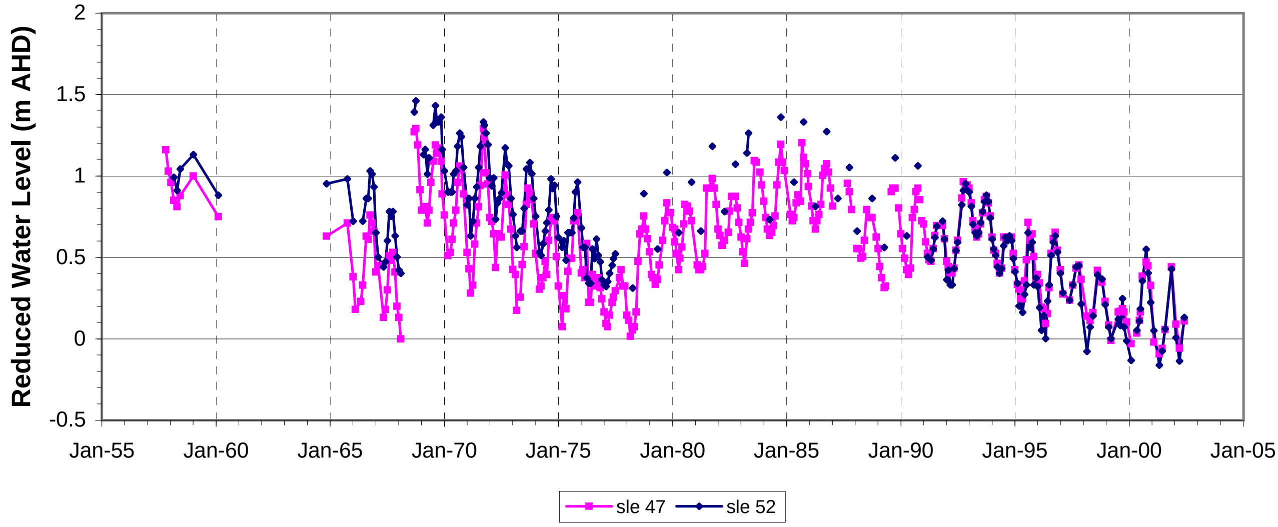
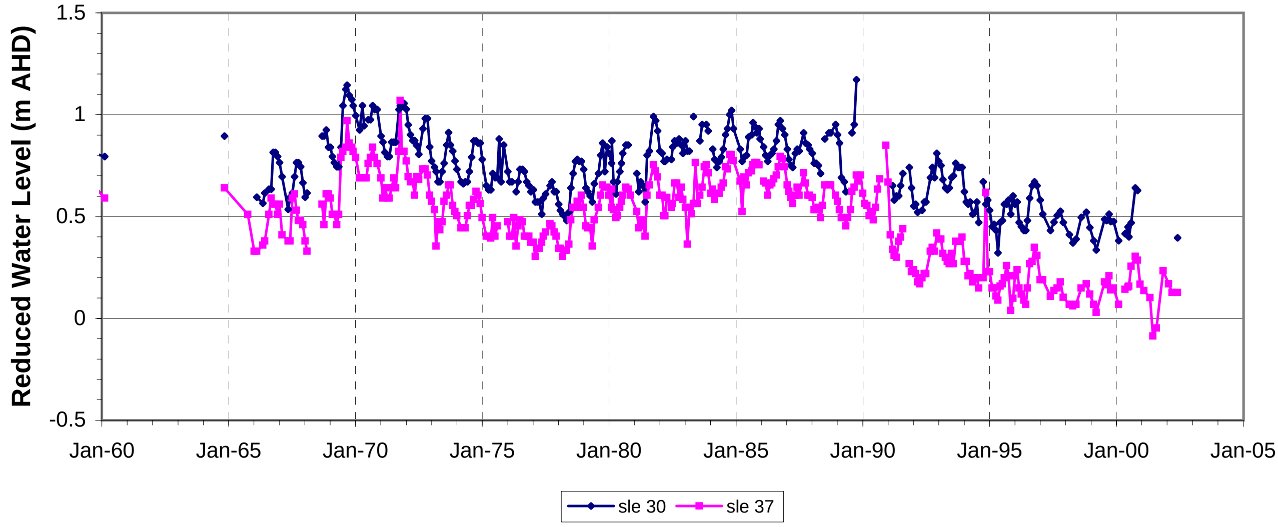


Figure 12 Uley East Lens, Quaternary Limestone Aquifer hydrographs

Lincoln Basin A Lens



Lincoln Basin B Lens



Lincoln Basin C Lens

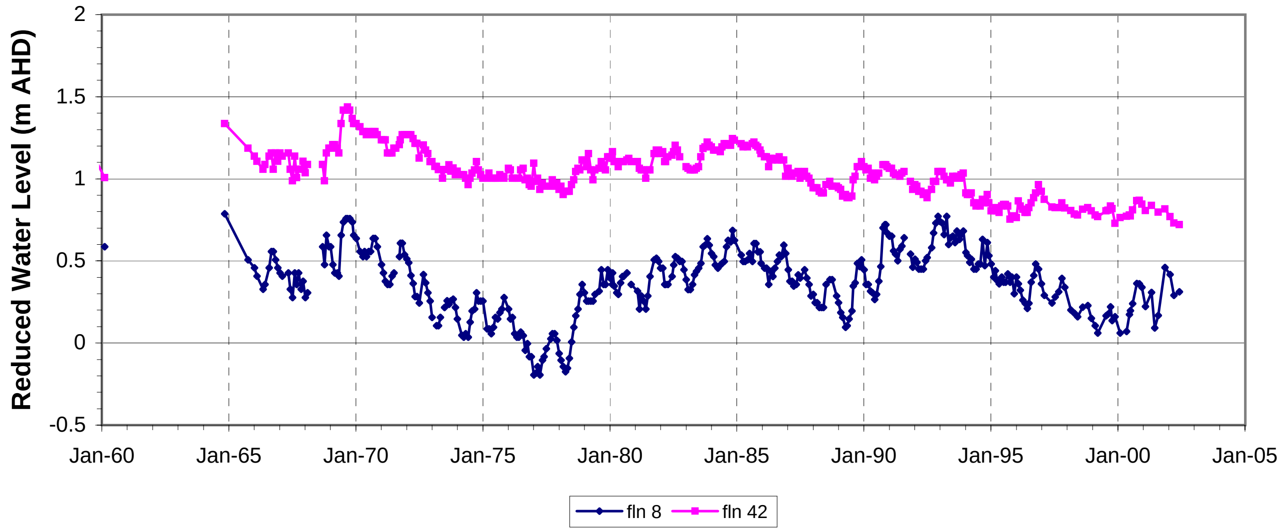
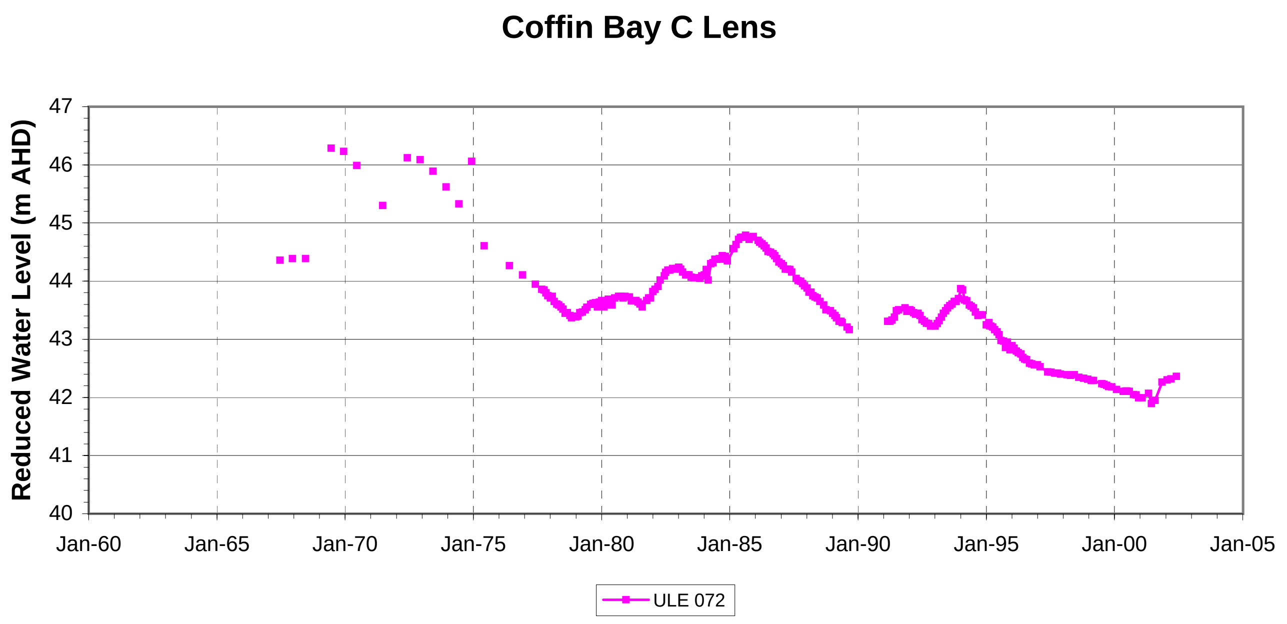
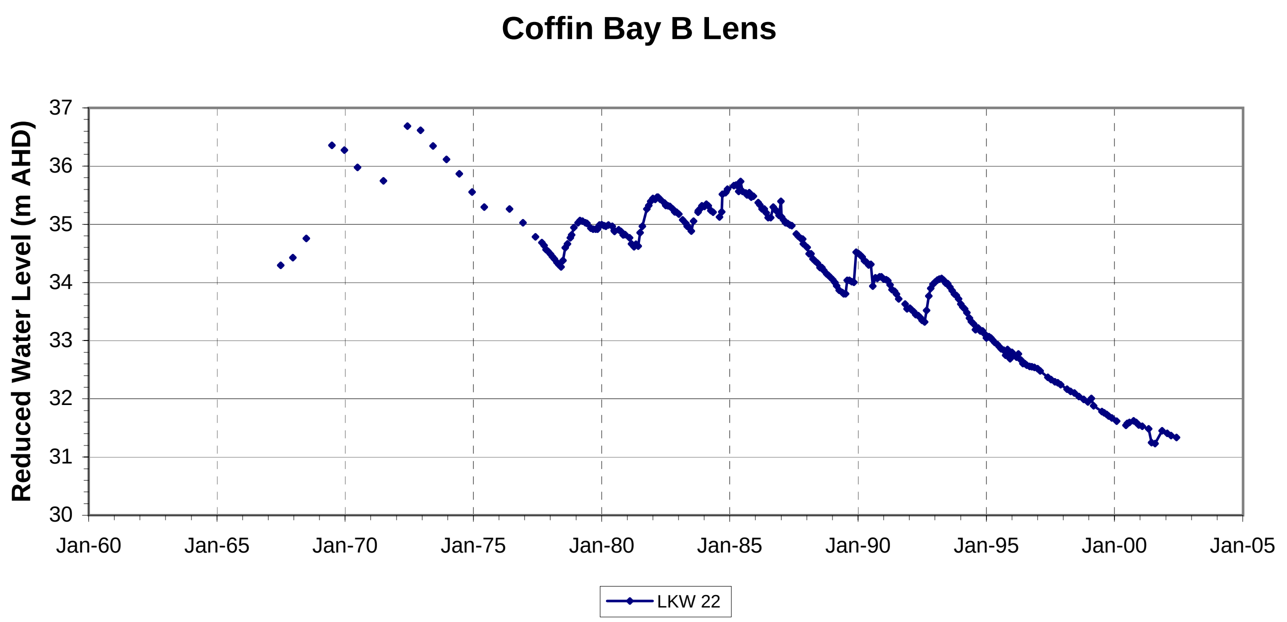


Figure 13 Lincoln Basin lenses, Quaternary Limestone Aquifer hydrograph





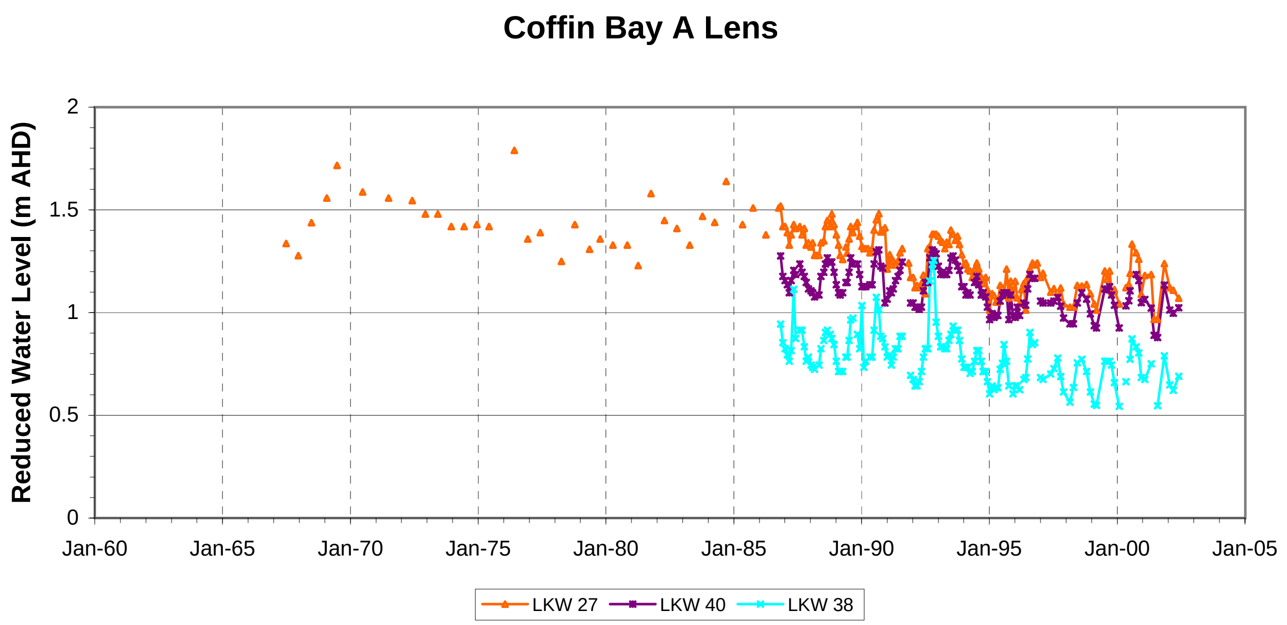


Figure 14 Coffin Bay lenses, Quaternary Limestone Aquifer hydrographs

The results of monitoring over the last 12 months indicate a moderate rise in groundwater level in the Uley South Lens. The cause of this rise is believed to be from the combined effect of recharge of rainfall and the continued recovery of groundwater levels from the reduced rate of extraction in the vicinity of the original well field.

Within the Lincoln Basin A, B and C and Coffin Bay A Lenses groundwater levels are remaining steady.

The recent return to average rainfall patterns is yet to manifest itself as water level rises in the Uley Wanilla, and Coffin Bay B and C Lenses.

Monitoring of groundwater levels within the Lincoln Basin D Lens is not currently undertaken. It is anticipated that groundwater trends within this aquifer system have remained steady over the last 12 months, albeit at low aquifer storage levels.

Groundwater quality trends

Since monitoring began, groundwater quality has fluctuated within a small range, despite relatively large extractions from some lenses. The main reason for this is that most of the lenses are isolated from saline waters that could mix under the stress of pumping. The Lincoln Basin is the resource most susceptible to increased salinisation when over-extraction induces groundwater mixing with the adjacent seawater.

Salinity trends from the most recent pumped sampling program (1992–97) and the recent investigation program (see below) at Uley South indicate that there has been virtually no change in aquifer salinity (Fig. 15). The erratic salinity curve of Coffin Bay observation well LKW 041 is likely to be due to the bailed method of sampling. Bailed sampling has been shown from the Robinson lens investigations not to give reliable representation of aquifer salinity.

Salinisation of aquifers can be commonly associated with crop irrigation over unconfined aquifers, whereby the majority of water borne salts remain in the soil profile to be subsequently recycled back to the aquifer with recharging water. Within the Southern Basins, water borne salts are removed from the recharge area by extractions for public water supply purposes, thus irrigation induced salinity rises, if they were to occur, would be limited to the smaller isolated licensed irrigation activity.

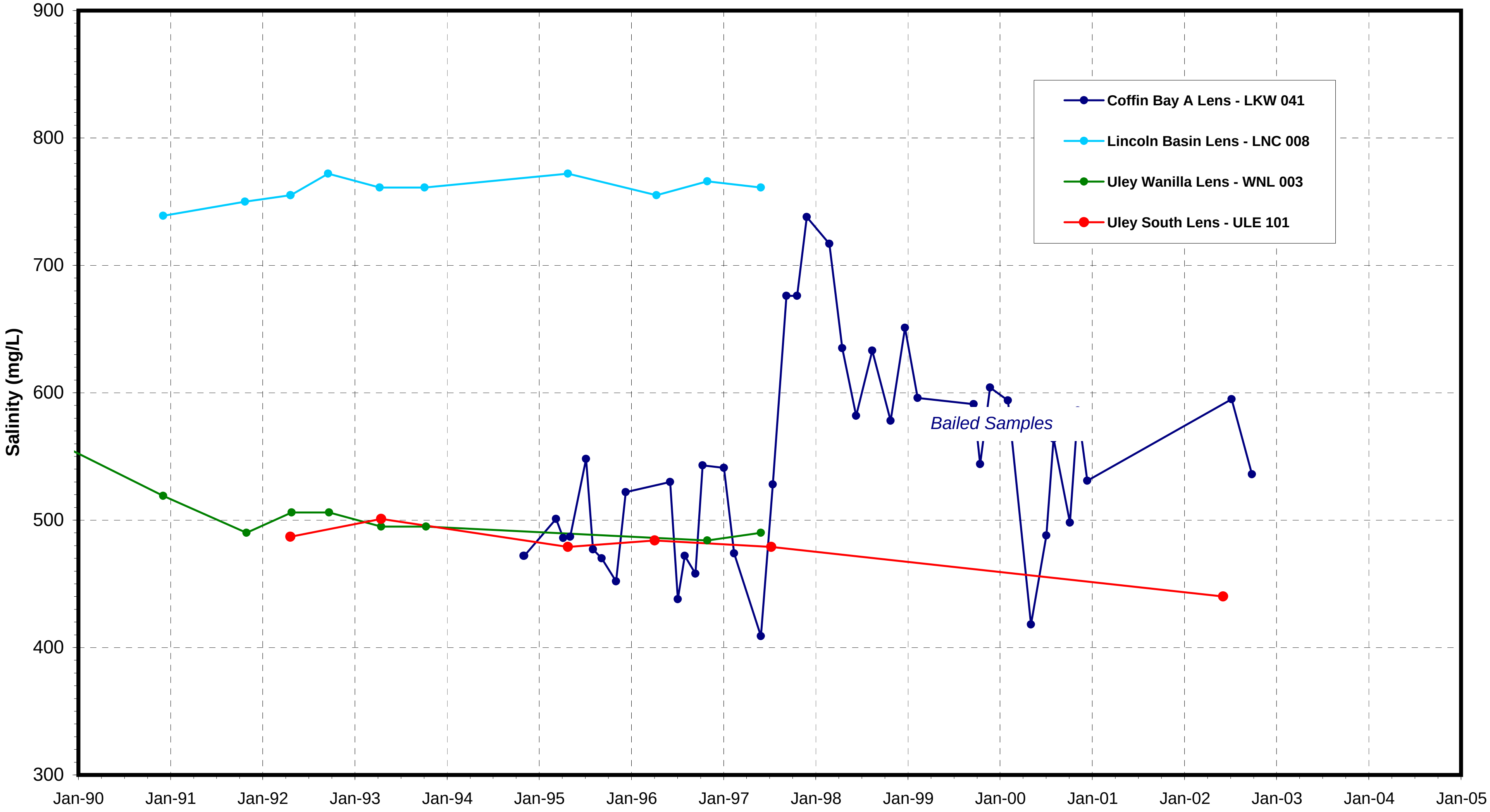


Figure 15 Salinity graphs of observation wells representative of the Quaternary lenses

CURRENT INVESTIGATIONS

Due to the high dependence the region has on the Uley South lens, the limited understanding of the extent of the Coffin Bay A lens and the proximity of these two resources to the coastline DWLBC, with the support of SA Water, are undertaking an evaluation of the condition of the monitoring networks within these resources in the Southern Basins Prescribed Wells area.

The scope of the investigation includes;

- Review spatial extent and adequacy of existing monitoring wells and frequency of monitoring,
- Purge, clean and redevelop/deepen wells to obtain true downhole salinity profiles using SONDE and collect pumped samples for electrical conductivity (EC) determinations,
- Undertake preliminary geophysical TEM surveys to enhance the understanding of basin geometry and to establish the existence of salt water intrusion into the fresh groundwater resources,
- Identification of sites to establish additional monitoring wells to enable an assessment of the potential threat from saline intrusion to be made, and
- Identify sites for equipping with remote monitoring devices.

The anticipated outcomes include;

- Enhanced definition of basin geometry,
- Definition of current spatial variability of salinity within Southern Basins PWA, including the existence of the fresh/salt water interface,
- Establishment of a more rigorous monitoring framework to facilitate the management of the resource, and
- Identification of the scope of works to be undertaken to understand the hydrodynamic behaviour of these systems in response to recharge and pumping demands.

Progress to end of June 2002 include;

- The inspection of the current County Flinders monitoring network, purging, TDS sampling and measuring water level and total depth of the majority of the observation wells within the network,
- The sonding of the majority of the observation wells of the current network in the Uley South and Coffin Bay A lens regions,
- The identification of instrumentation sites for groundwater level and rainfall intensity monitoring, and
- The undertaking of TEM geophysical survey in the Coffin Bay A lens region.

SHORTENED FORMS

Measurement

Name of unit	Symbol	Definition in terms of other metric units	
Day	d		time interval
Gram	g		Mass
Kilometre	km	10^{3} m	Length
Litre	L	10^{-3} m^{3}	Volume
Metre	m		Length
Metres per day	m/d		
Milligram	mg	10^{-3} g	Mass
Milligrams per litre	mg/L		
Megalitre	ML	10^{-6} m^{3}	Volume
Millimetre	mm	10^{-3} m	Length

General

Shortened form	Description
AHD	Australian height datum
DWLBC	Department of Water, Land and Biodiversity Conservation
PWA	prescribed wells area
TDS	total dissolved solids